CDF at Argonne

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May 12, 2004

DOE Review of ANL/HEP

CDF Physics

- Fantastic B physics prospects including non B_d ; mixing and spectroscopy (B_s Mixing eventually)
- Greater precision EWK (m(W) m(t)), searches
- Advance QCD studies including PDFs
- Higgs search would have been icing
- "Run till LHC is doing physics"
- Expectations still excellent - sample keeps on doubling, get to 40 times run 1

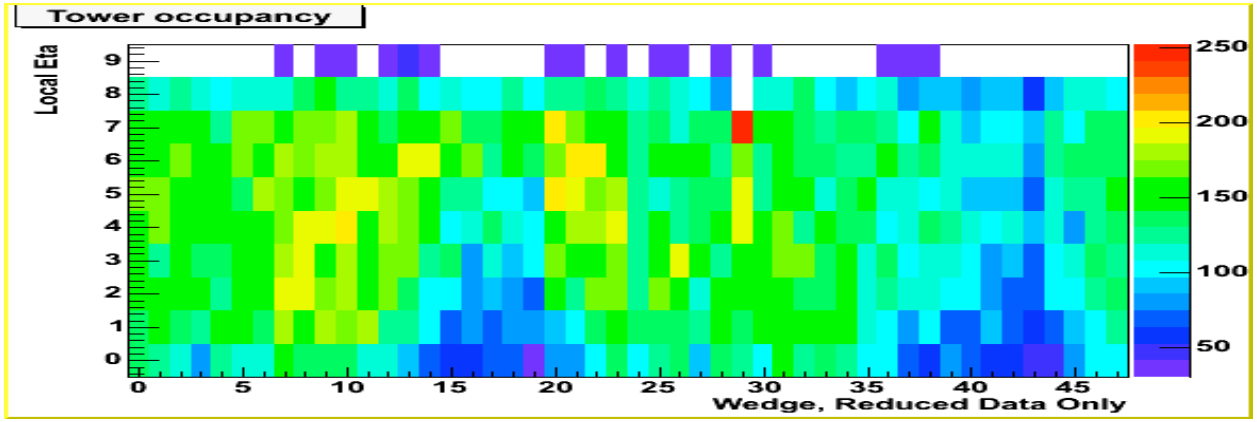
Current CDF Status

- Physics samples 250 pb^{-1}, mostly with silicon, 90 more with compromised COT
- Luminosity has been growing 7 $x10^{31}$ best
- Detectors OK for most physics
- L2 trigger for jets, e/γ, track impact working, Trigger OK to >5 $x10^{31}$ (better if COT on)
- Silicon: SVX 90%, includes L00
- DAQ eff. OK, offline keeps up - 2 passes
- Tracking algorithms still improving

A Note on COT Reduced Data

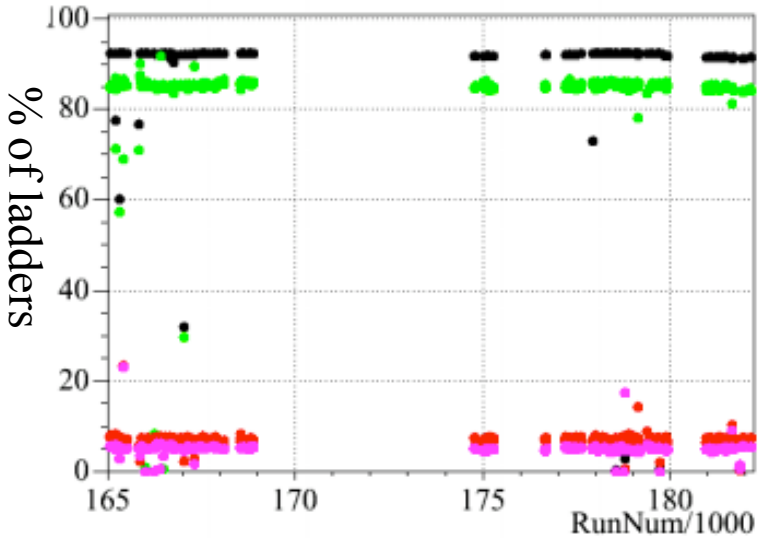
Hydrocarbons coating wires locally with luminosity - stagnant gas?

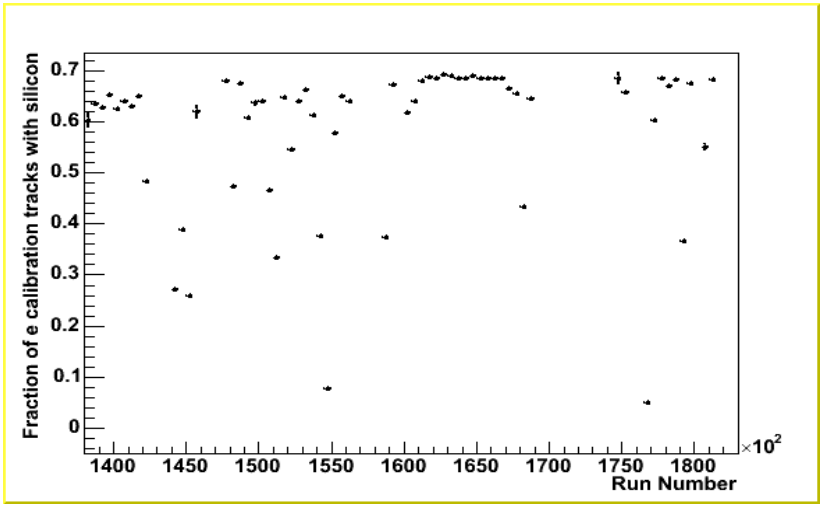
Tower map of 8 GeV e calib triggers Φ twice around Local eta outside up



- Last 90 pb^{-1} SL1,2 (3) off, 4,5 50% gain
- Trigger modified to ignore 2, take 9/12 in 4 -local problem
- Rate capabilities somewhat reduced
- Could do most physics but local inefficiency (particularly in the trigger) will make it difficult
- Hope to fix soon enough not to worry too much about optimizing living with it
- Will try gas flow upgrade this week. Additives? ArCO2?

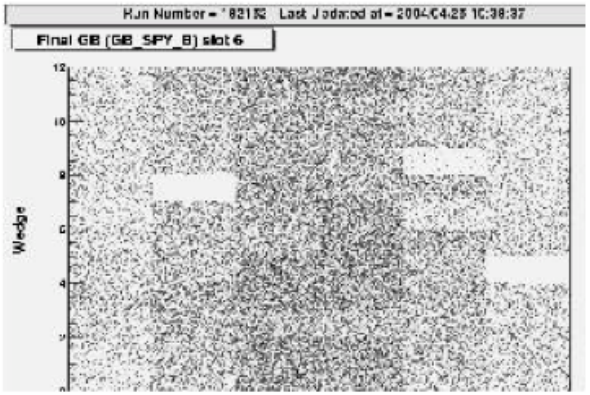
Note on Silicon Survival





Black on, green good, red/pink bad

Trigger coverage remains fairly complete

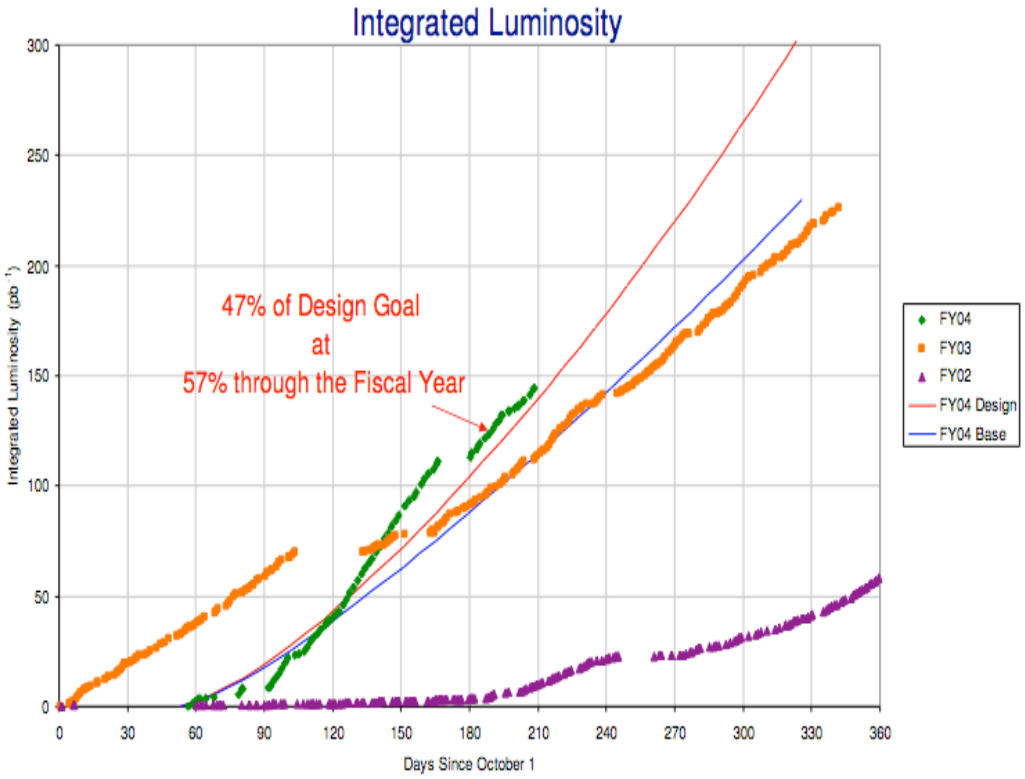


Φ

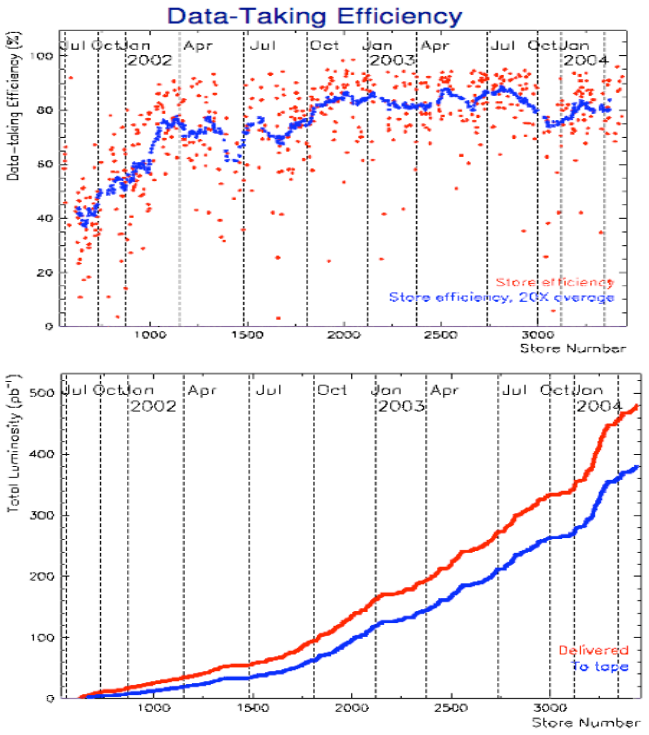
Two thirds of central tracks when no beam incidents

Half barrel (z)

Performance So Far

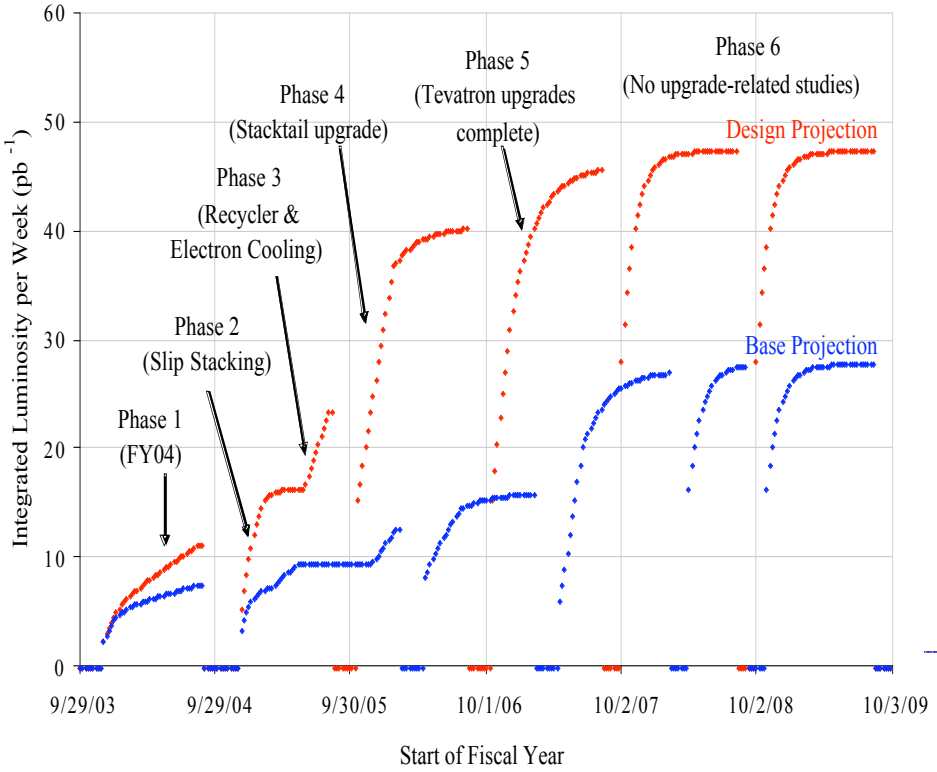


TeV ahead of 04 plan till lately

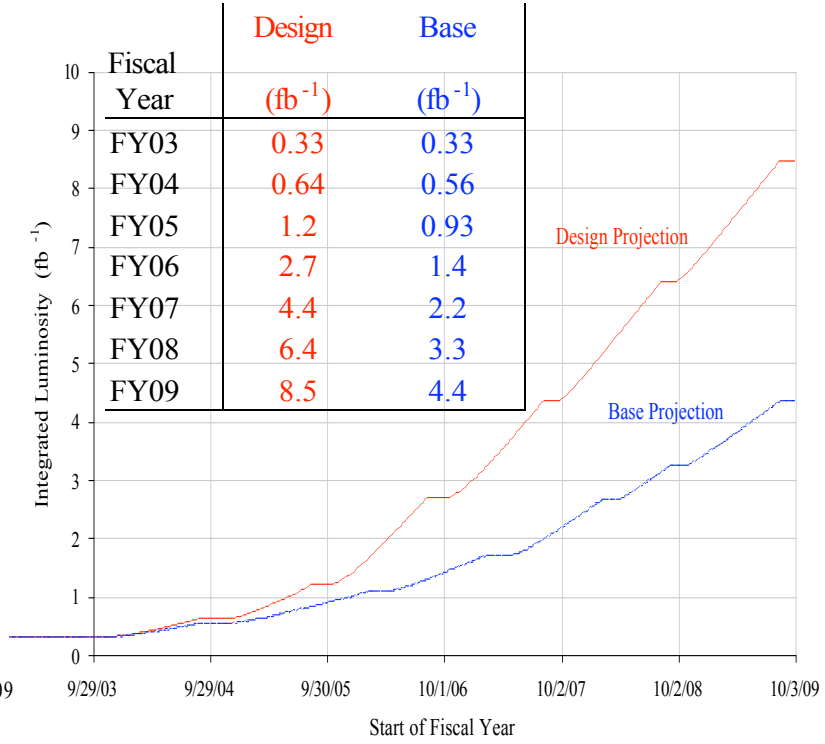


CDF a bit distracted by COT issues and threats to silicon

Expectations: Long Term



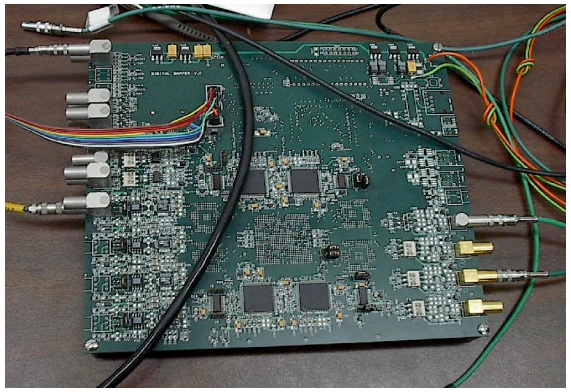
Fiscal Year	Design (fb^{-1})	Base (fb^{-1})
FY03	0.33	0.33
FY04	0.64	0.56
FY05	1.2	0.93
FY06	2.7	1.4
FY07	4.4	2.2
FY08	6.4	3.3
FY09	8.5	4.4

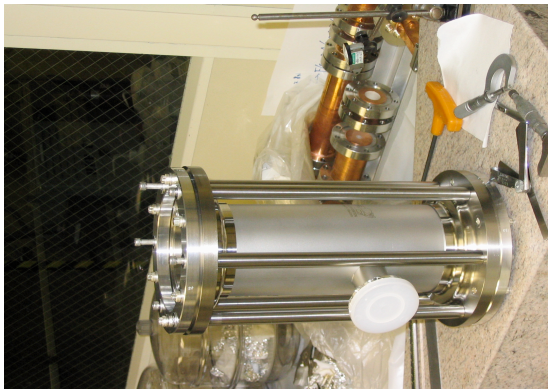


From last DOE review (Spaulding)

Argonne Support for the Tevatron

- Some years ago Herman Grunder declared Argonne support for the TeV Collider
- This has involved effort outside/inside HEP
- Curently 3 efforts in HEP Division:
  - Wei Gai e cool support LDRD funded
  - Jim Norem booster development LDRD funded
  - Bill Ashmanskas digital damper Compton Fellow/Cornell (CDF author @ ANL)





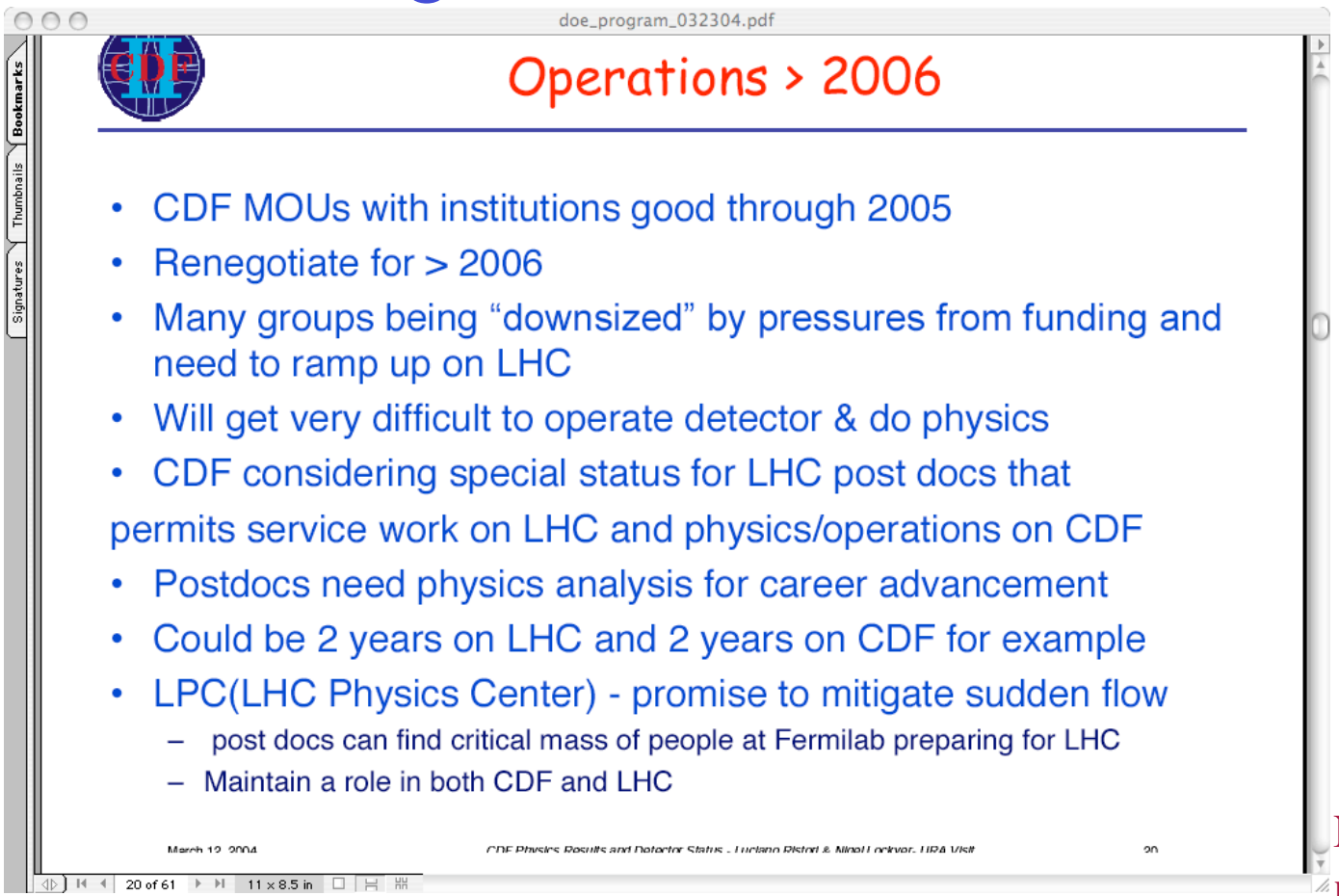
Comment on Prospects

- Sample size is now big enough to be interesting
- Sample should keep doubling till 08 - continues to be interesting - downright exciting!
- Sample will be big enough to find effects for which run 1 had no hint
- Should have opportunity to make good use of CPR upgrade
- Gas change should restore COT if plumbing upgrade is not sufficient
- B triggers ok if COT ok although strategy will evolve with luminosity
- We are committed to holding up our end and we all have someplace else to go (FTE declining)
- Continuation ideas being floated (gluons, b's …) but nothing so far to distract us from post CDF plans
- Run till LHC physics program, publish last papers, fade away 30+ years
- Personally, this is as good as it gets, better if we find something …

Argonne Role in CDF

- Past physics
  - Leaders in developing B physics program
  - Leaders in photon physics, QCD and searches
  - Leaders in precision EWK (m(W))
  - Filled about 10% of Physics Convener 2 year terms
- Run II Operation Support
  - Take key responsibilities as needs grow (Management, shift leaders, SubProject Leaders)
  - Tune up Central EM Calorimeter
  - Maintain Shower Max Electronics
  - Support the Level 2 Trigger
  - Pager support for cal, shower max electronics, shower max HV, shower max trigger, ISO trigger
- Preshower and crack upgrade

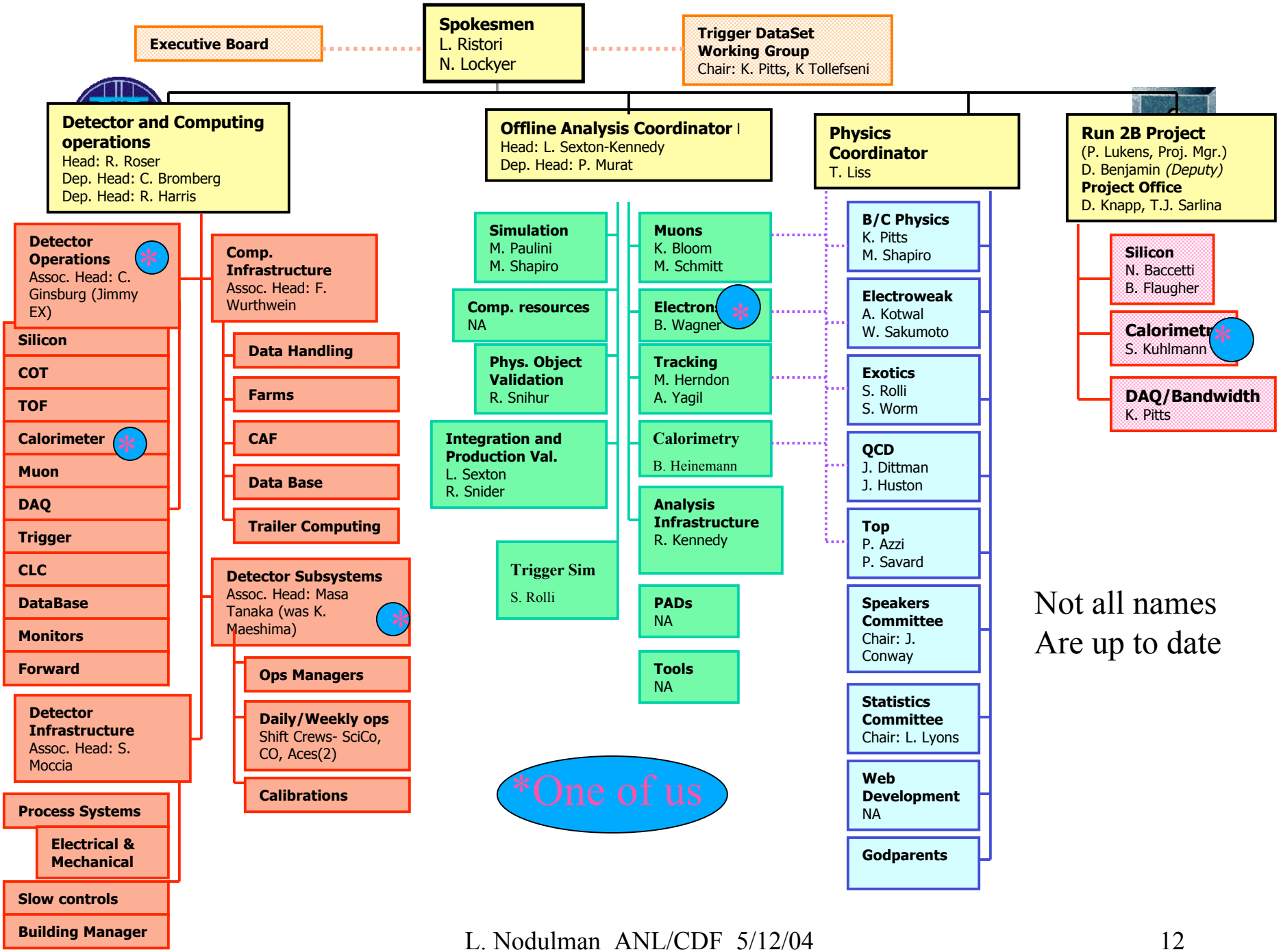
CDF Management
Long Term OPS Concerns



CDF Spokes @URA

HEPAP presentation: need 109 FTE ops 200+ analysis

New round of MOUs


Executive Board
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L. Ristori
N. Lockyer
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Chair: K. Pitts, K Tollefseni
Detector and Computing operations
Head: R. Roser
Dep. Head: C. Bromberg
Dep. Head: R. Harris
Offline Analysis Coordinator
Head: L. Sexton-Kennedy
Dep. Head: P. Murat
Physics Coordinator
T. Liss
Run 2B Project
(P. Lukens, Proj. Mgr.)
D. Benjamin (Deputy)
Project Office
D. Knapp, T.J. Sarlina
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Assoc. Head: C. Ginsburg (Jimmy EX)
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TOF
Calorimeter
Muon
DAQ
Trigger
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Assoc. Head: S. Moccia
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Building Manager
Comp. Infrastructure
Assoc. Head: F. Wurthwein
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Farms
CAF
Data Base
Trailer Computing
Detector Subsystems
Assoc. Head: Masa Tanaka (was K. Maeshima)
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Simulation
M. Paulini
M. Shapiro
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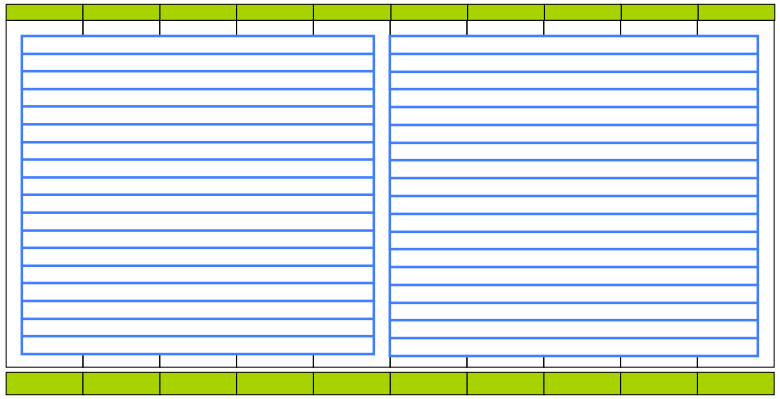
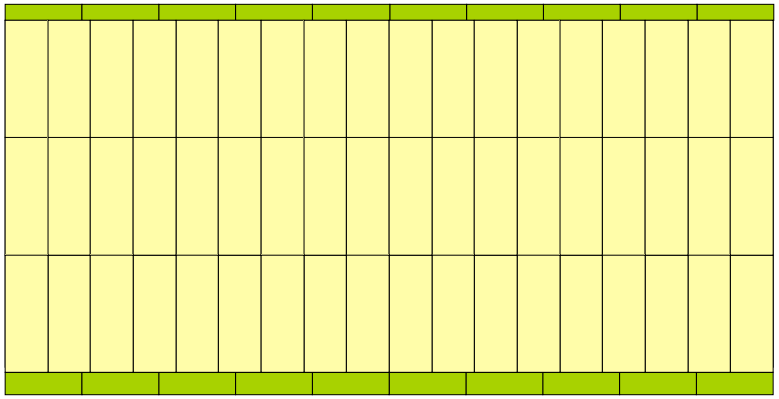
S. Kuhlmann
DAQ/Bandwidth
K. Pitts
*One of us
Not all names
Are up to date

Argonne Leadership CDF

- Deputy Head of CDF Operations (Proudfoot, Tanaka)
- Calorimeter Group co-head (SPL) (Nodulman)
- Electron/calorimeter offline reconstruction (Wagner)
- Physics Group Reps at Trigger/Dataset Working Group (Wicklund (B), Nodulman (top/EWK))
- B Physics subgroups: LeCompte, Tanaka
- Retired QCD Physics co-convener (Blair)
- Dijet mass group (Kuhlmann)
- Run IIb Calorimeter (CPR/CEM timing) upgrade L2 Manager (Kuhlmann)
- Head godparent for lepton + jets top mass (Nodulman)

Preradiator Upgrade Project
Wedge Front Face





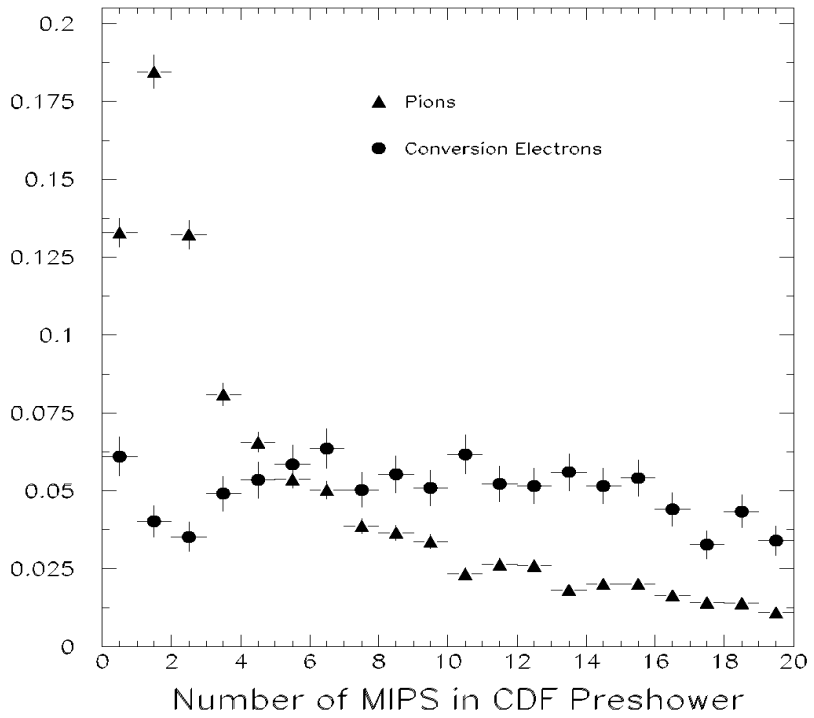
Now: preradiator wires (16 x 2) along z,
crack pads match towers, crack chambers ~80% functional

54 sigma tiles read out same as plug shower max/prerad., no frame, crack also scintillator

Argonne collaborating with MSU, Tsukuba, INFN (Pisa, Rome, Trieste, Padova), Dubna, Rockefeller, FNAL

Why Upgrade?

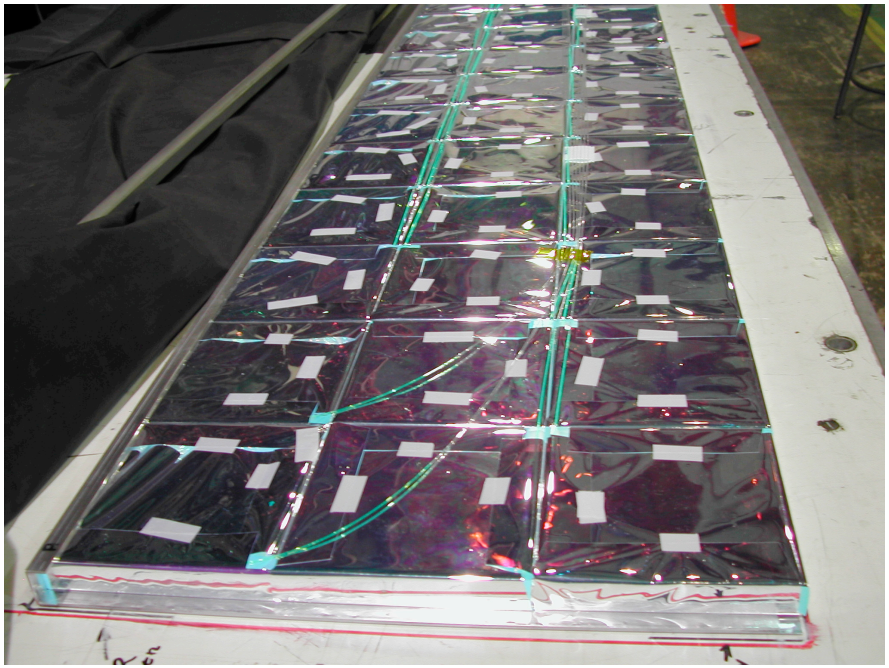
- Retain preshower γ and e (particularly soft) ID
- Optimize preshower data for dijet resolution (H, searches)
- Better crack coverage would help dijet (H)
- Can install in the pit, scaffolding made (survives silicon upgrade)



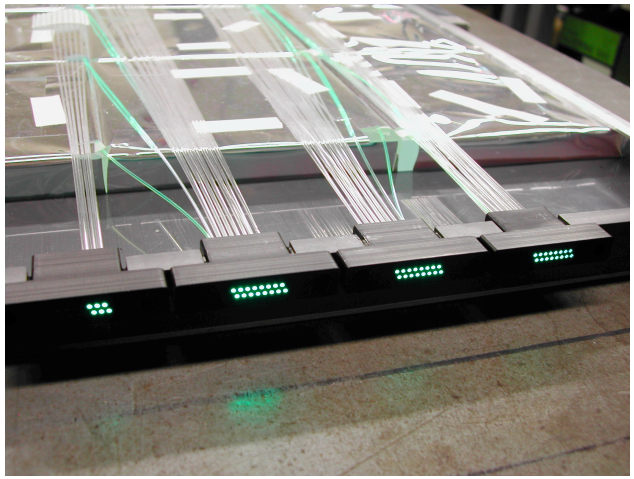
Practical 2b Implications

- Design work here (Jim Grudzinski) (MOU)
- Russian plastic, Japanese multianode PMTs, Italian HV, recycle readout electronics (existing and external resources)
- Assembly (here) started now with guests
  - Preradiator and crack packages
  - Transition boards
- Kuhlmann running the show (**on budget & early**)
- Recycle MINOS scanner, STAR cosmic test stand
- Install all this fall, tight, fallback complete fall 05 (was 06 with si)

Even More Practical

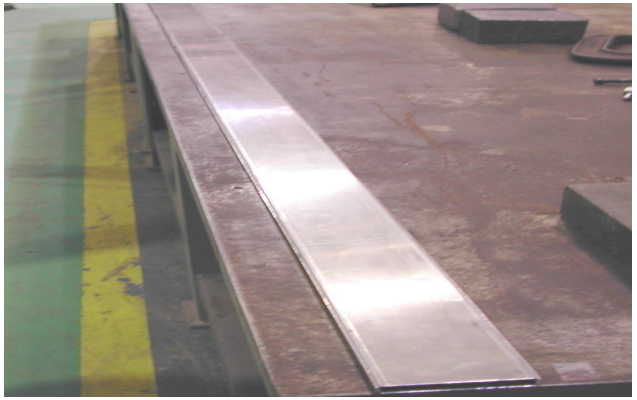


Preradiator panel assembly

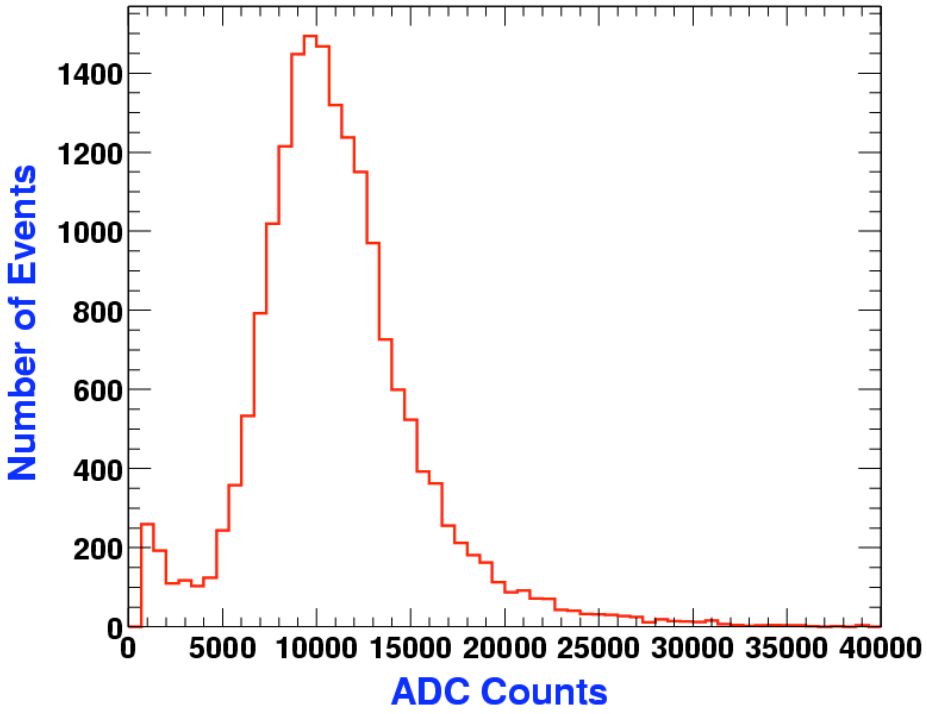


Optical connectors on panel

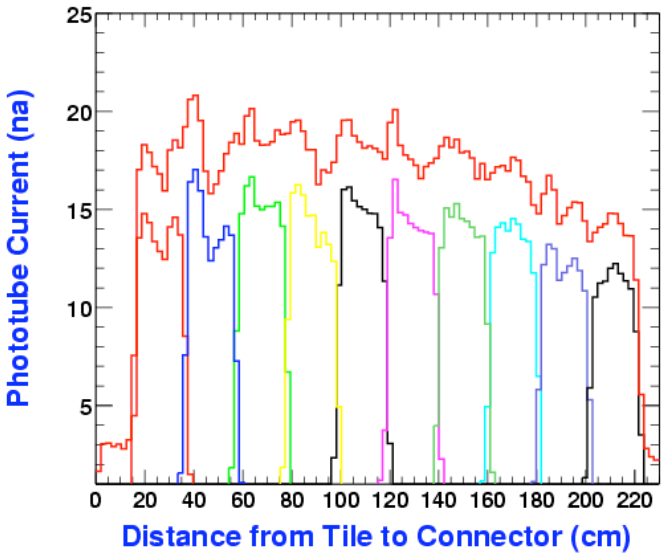
crack



And They Work!



MIP peak on **STAR** stand confirms >16 pe through full preradiator optics



Source scan of crack detector on **MINOS** stand for cross talk study

Doing Physics in CDF

- Incredibly diverse and important physics program
- Large numbers of refugees from HERA & LEP, young, bright, enthusiastic, inexpert (where are the American aces?), training for LHC
- Our group are experts on using CDF data, central EM e/γ in particular but also tracking, material and scale issues etc.
- We tend to work with several analysis groups, eg Blair & Kuhlmann QCD/γ/searches, Nodulman mW/mt, Tanaka, Wicklund, etc. B physics
- As various CDF FTE shrinks and support roles remain, physics participation will be a challenge to maintain
- Sample keeps doubling, important to create good tools

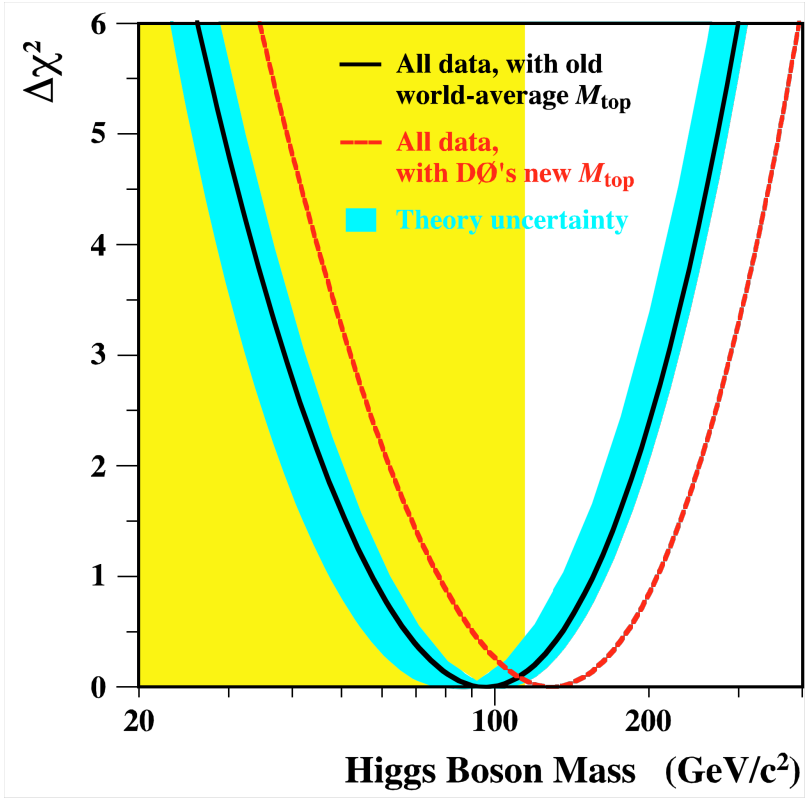
Do Physics & Share Expertise with University Groups

- B Physics: Penn, CMU, Purdue, Tsukuba, Glasgow, Pitt, Okayama, FNAL
- Charm Physics: Wayne State
- W Physics: Toronto, Duke
- Top physics: Berkeley, Chicago, Waseda, FNAL, Liverpool
- Photon Physics: MSU, Geneva
- Dijet Optimizing: Rockefeller, Rutgers, Chicago, Berkeley
- Cal Ops: Rochester, UCLA, Wayne State, CMU, Purdue, Frascatti, FNAL, TAMU
- Trigger Ops: Michigan, Chicago, Yale, FNAL

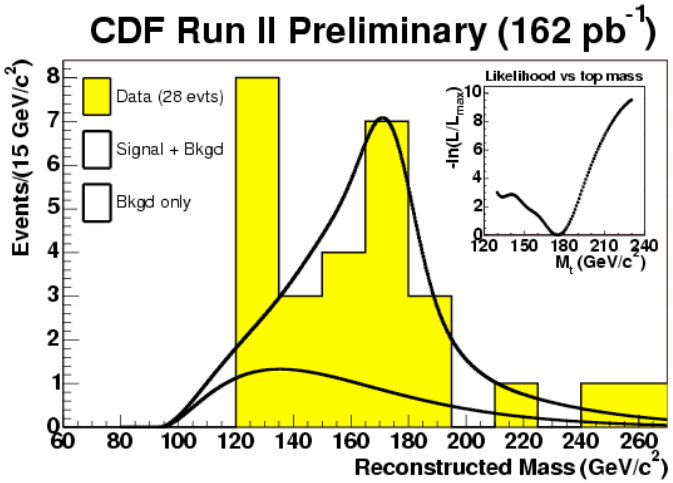
Top Mass is Important

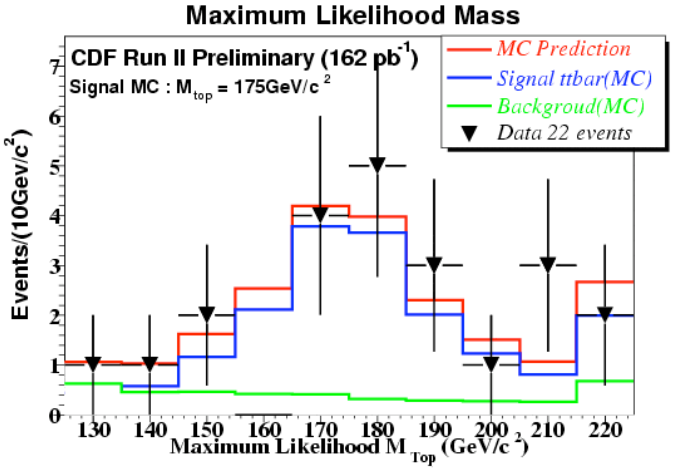
- Best leverage on EWK breaking
- Wicklund, Proudfoot, Nodulman, Kuhlmann are/have been scale experts
- Template, DLM fits now, D0 style coming
- Scale comparison with Run I is now fine but need better for Run II
- Tagging needs work SLT & SVX

New D0 Run I shifts things (174->179!)



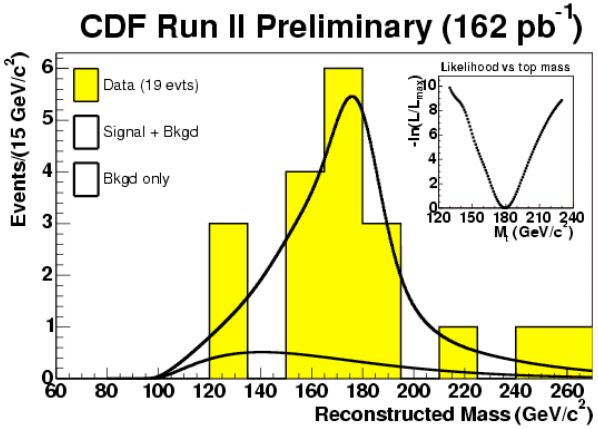
Conference Results to Comprehensive Paper with Better Reconstruction (lepton + jet with > 1 Si b Tag





Template, Run I like
A priori optimal
174.9 +7.1-7.7 ±6.5 GeV/c^2

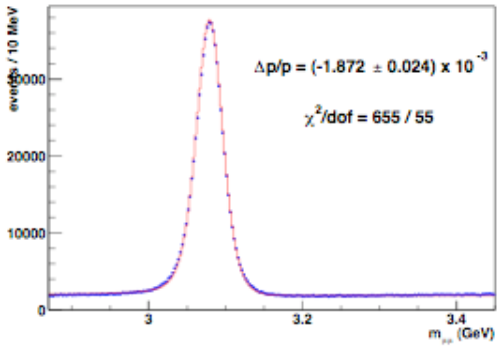
DLM fit ==4 jet
177.8 +4.5-5.0 ±6.2GeV/c^2

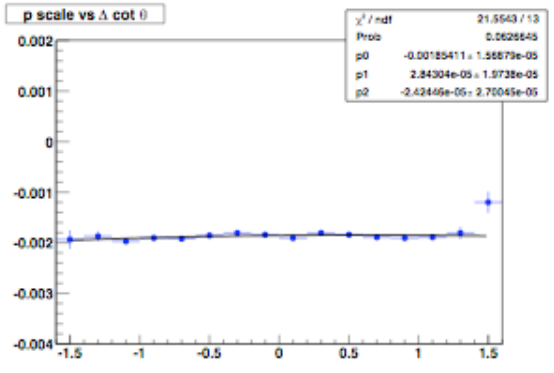


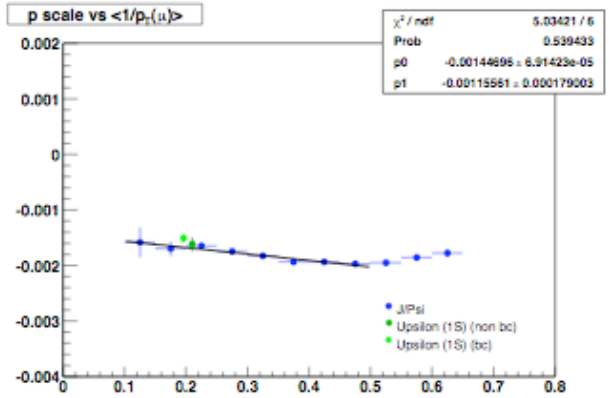
Template 4+ jets

Double tags?
SLT tags?
Scale?

W Mass in Process
Sample Competes with LEP

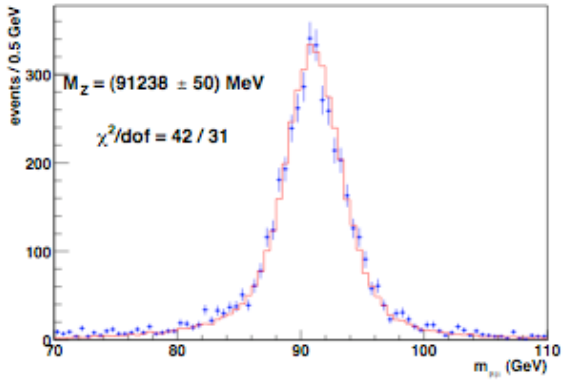




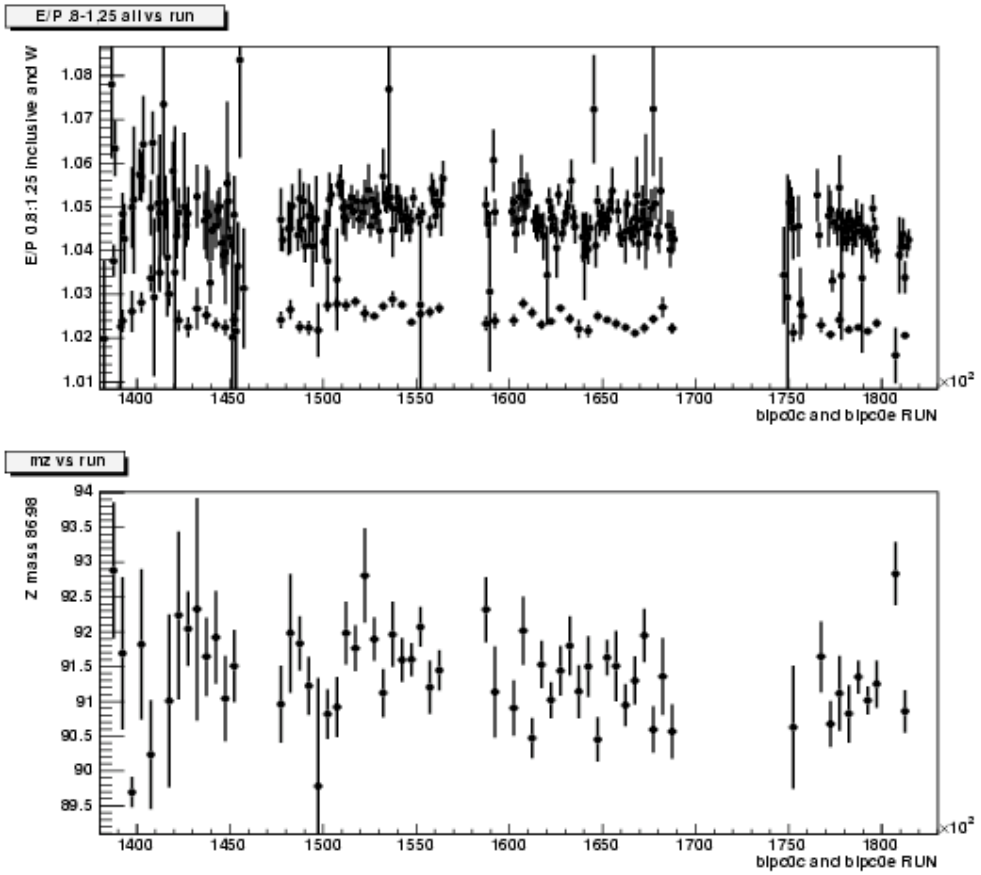


Use Ψ data to understand systematics, extrapolation in pT shows remaining material problem for latest version of tracking/reconstruction

Latest material map being installed



W Mass is Prime Customer for Calibrating CEM



Corrected, ~2.5 years

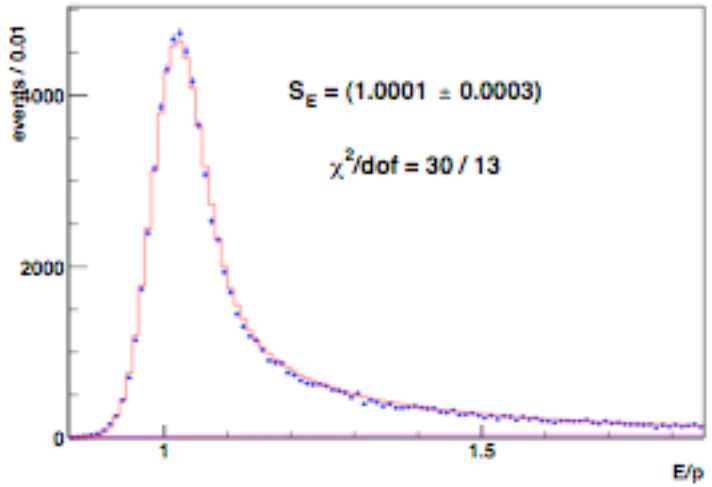
Average time dependence is similar to run 1, stay closer online

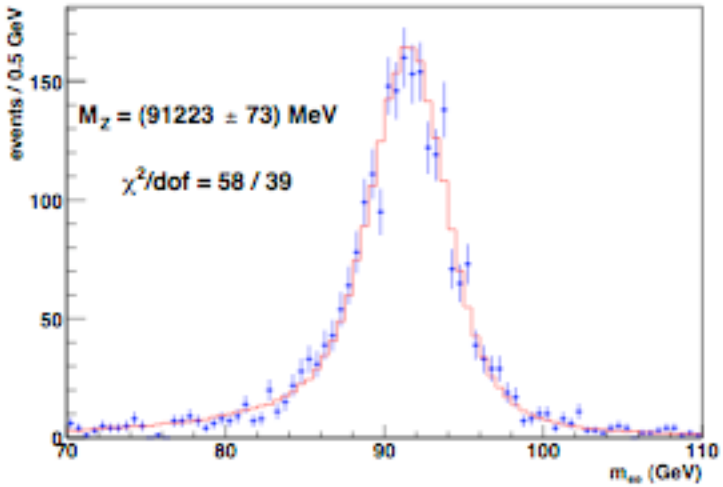
Tower gains updated for run ranges

Response map trim simple, no sign of attenuation getting worse

More W Mass

@Duke

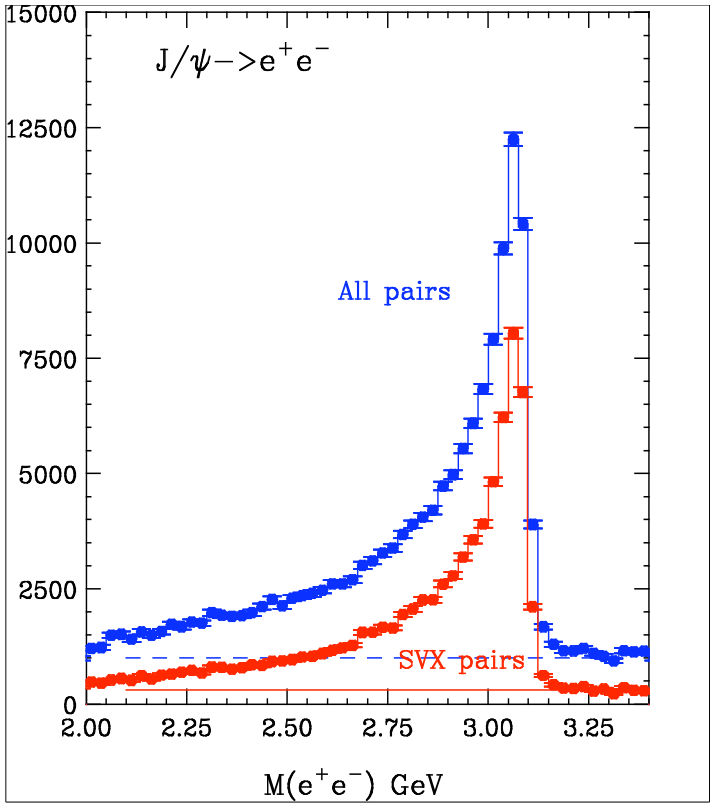


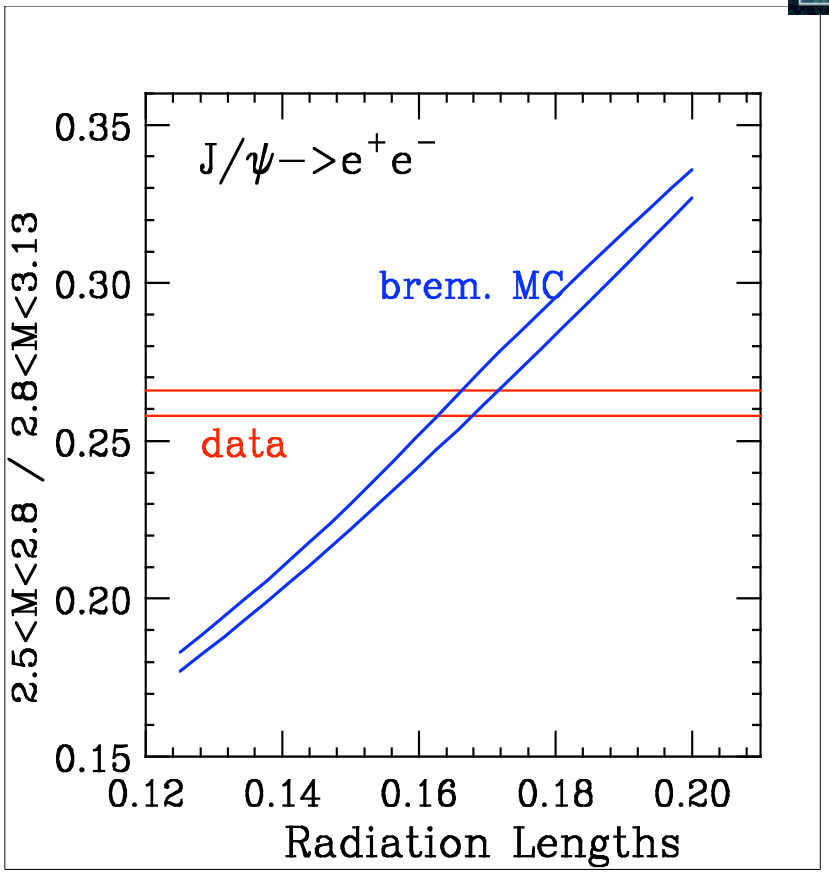


Unlike Run 1b so far we get consistent scale from Z mass and E/P. Constant EM resolution term **1.3%!**

Simulation tools and systematic studies mostly in place, hope for result this summer

J/Ψ => e^+e^- Material Calibration



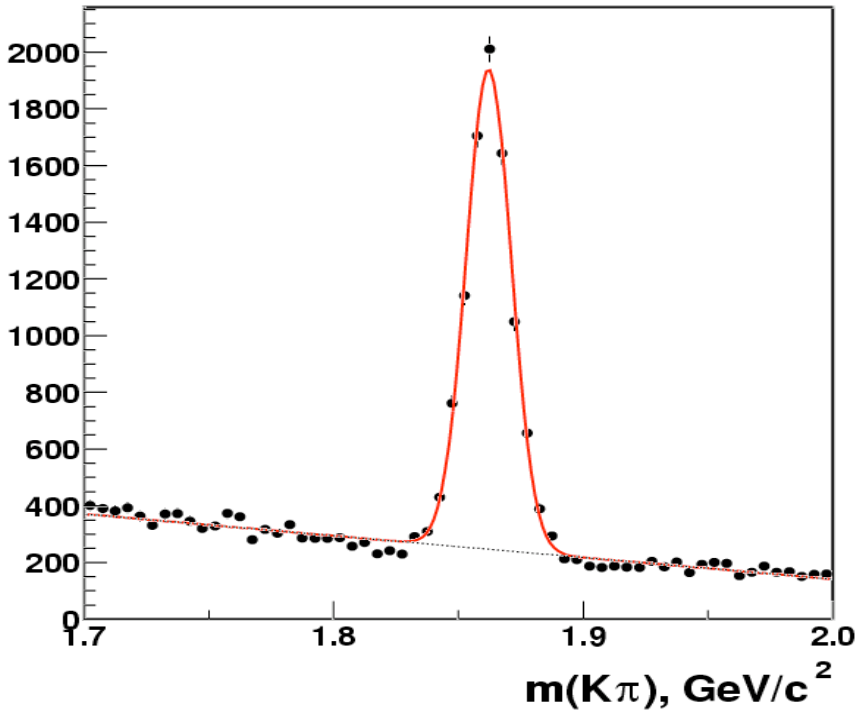


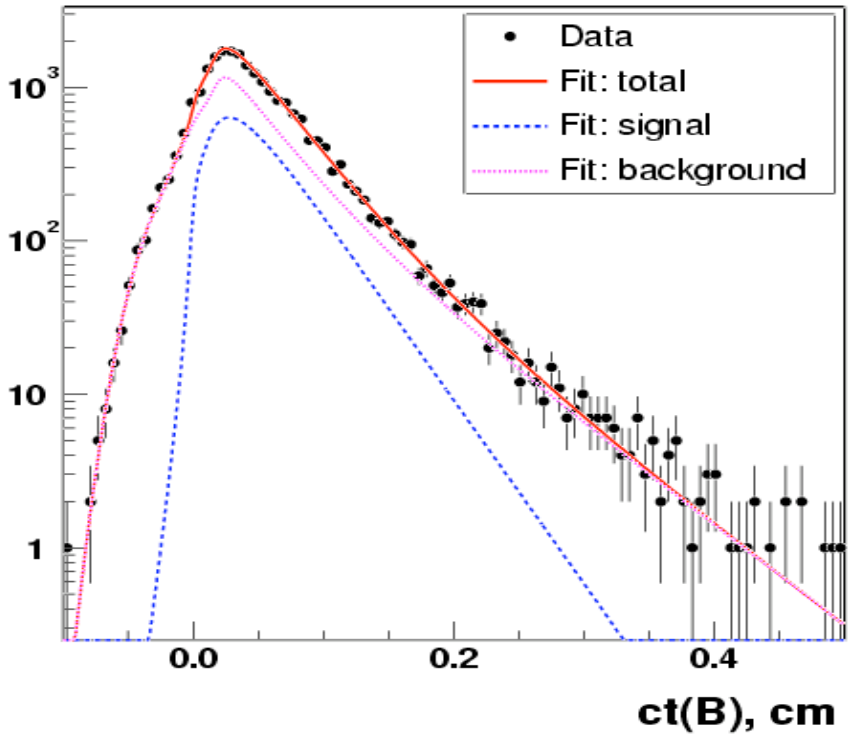
- **SVX pairs reduce backgrounds from double conversions**
- **Line shape (tail/peak) gives precise cross-check on Xo**
  compare with E/p and Z=>e^+e^- and new material map

CDF Semileptonic Lifetime Problem

Important step on the road to B_s mixing (Masa Tanaka)

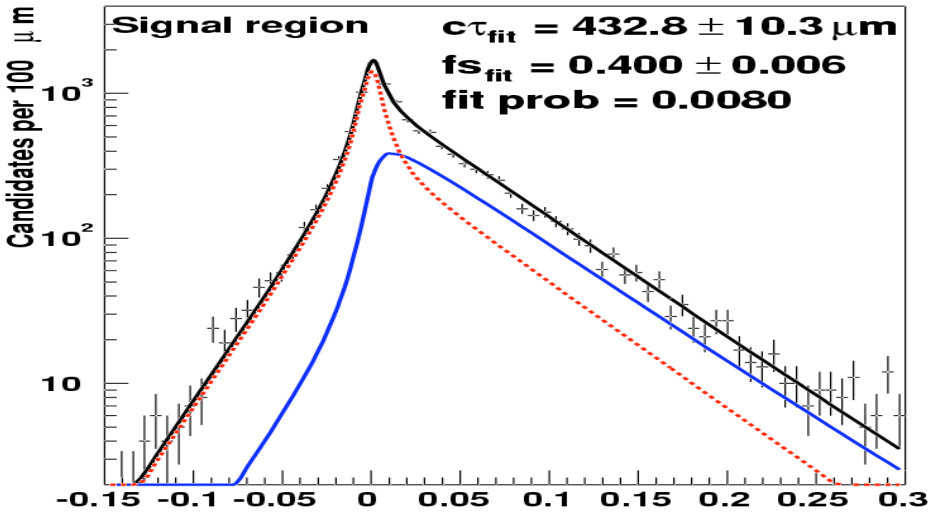
- 4 GeV lepton/ SVT trigger ($B \Rightarrow \mu D^0 X$)
- Independent cross checks
  - Reconstruction, K factor, trigger bias, Fitting framework
- Found: 429 ± 7 μm (expect 486 μm)

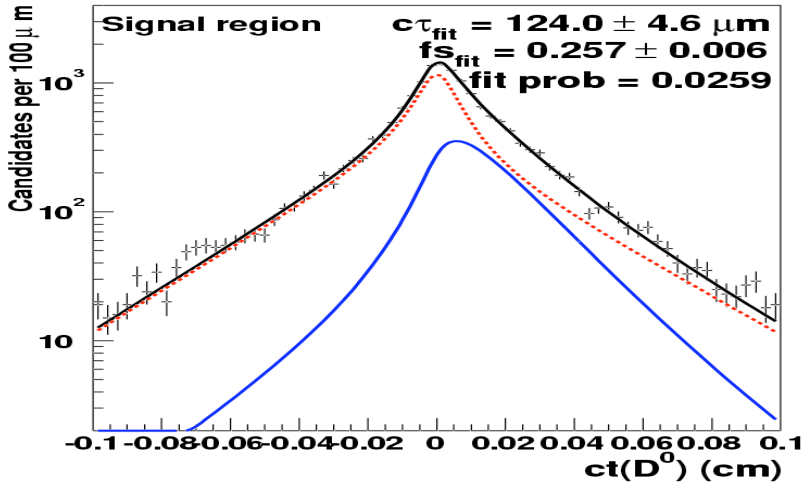




8 GeV Muon sample

- Reconstruct μ+D^0 in Run II 8 GeV muon dataset (~180 pb^{-1})
  - No bias from SVT
  - Same trigger as Run I analysis which gave correct lifetime
- 10% short B lifetime !
  - 432±10 μm (PDG: 488 μm)
- D^0 lifetime is ok
  - 124±5 μm (PDG: 128 μm

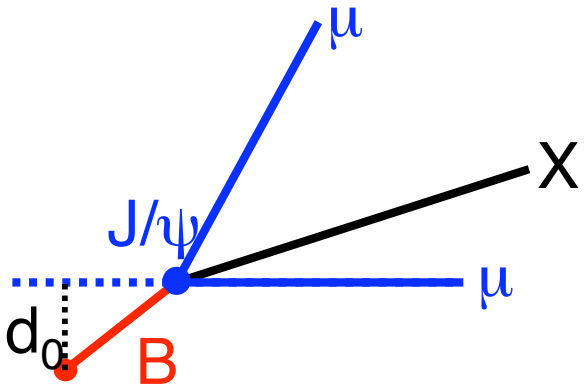


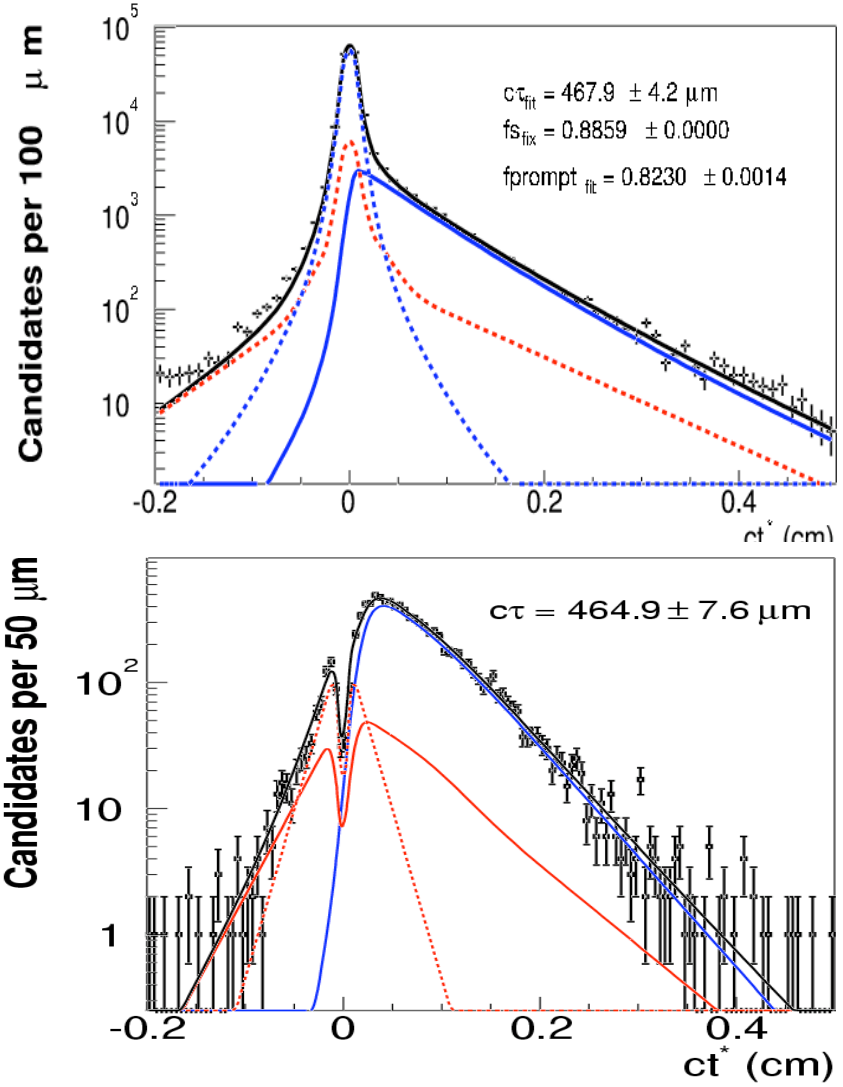


J/ψ inclusive Lifetime

We have done inclusive B lifetime measurement in J/ψ→μμ

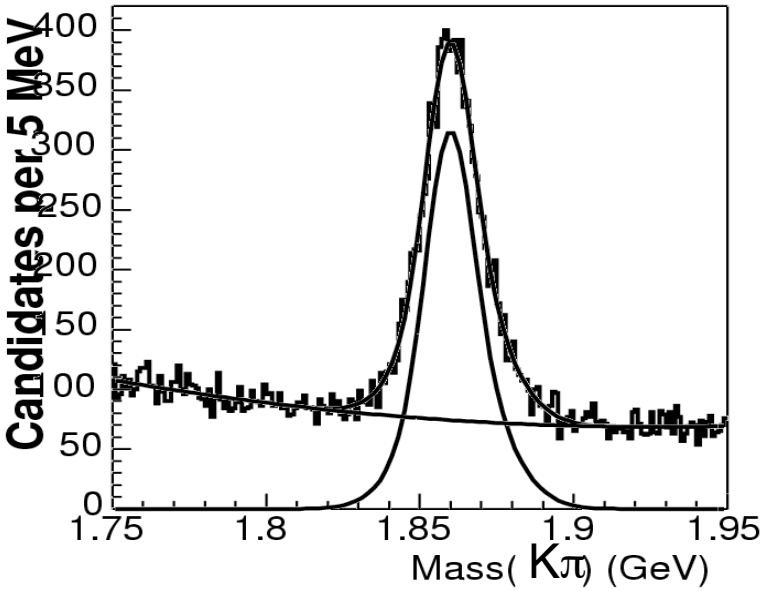
- Artificially apply the SVT bias
  - One of the μ to be SVT
- Measure average B lifetime
  - Use parameterized template
  - 468±4 μm (w/o bias)
  - 465±8 μm (w bias)
  - PDG: 471 μm
- Consistent with expectation

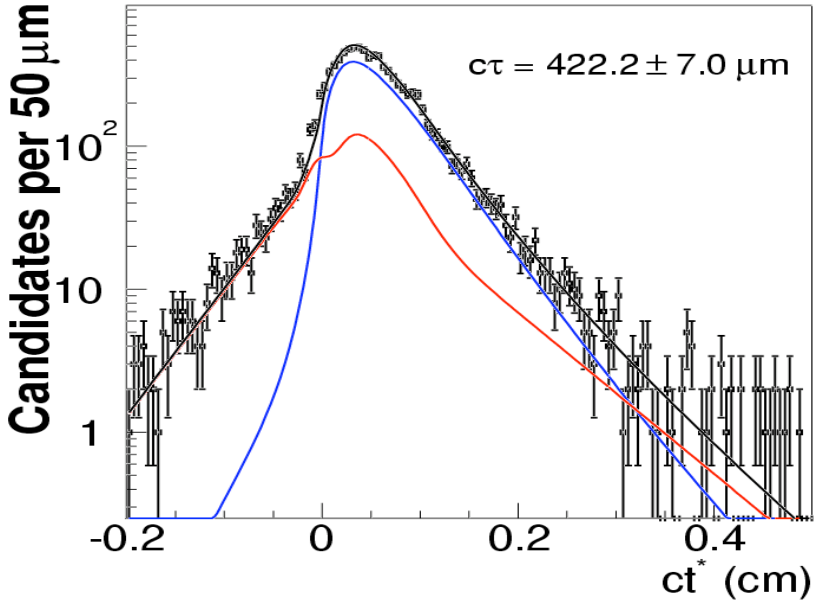




Independent Cross Check

- Use Signal likelihood based on parameterized template
  - 422±7 μm
- This and other cross checks give consistently 10% short lifetime
  - B physics group formed "B lifetime Task Force"
    - Barry Wicklund, Manfred Paulini, Fumi Ukegawa, Andy Foland





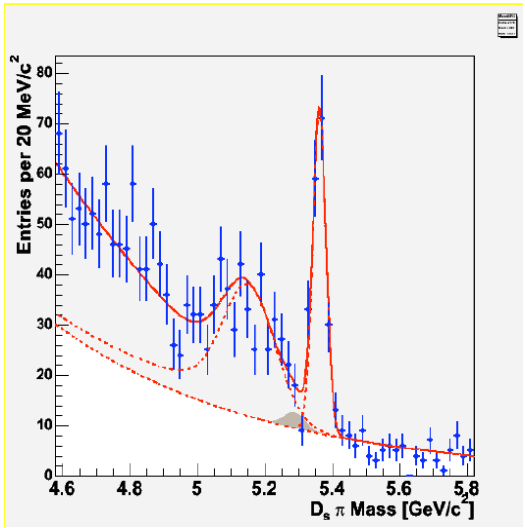
B Studies Progress Toward B_s Mixing

Mixing studies require b flavor tagging, strength is εD^2. So far we Have:

Jet charge	0.42±0.02%
Same side	1.0 ±0.5%
Soft μ	0.66 ±0.19%

Soft e (in progress)

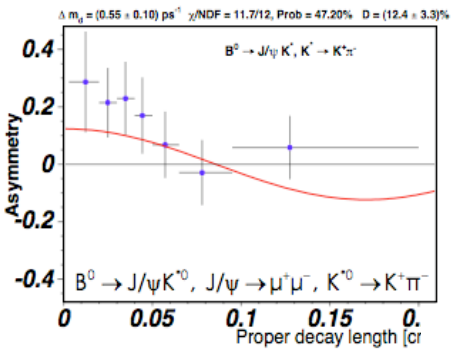
Kaon (TOF) (in progress)

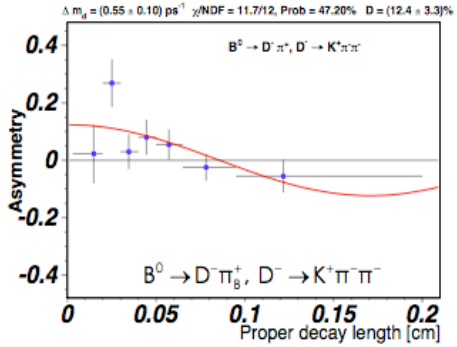


B_s signal

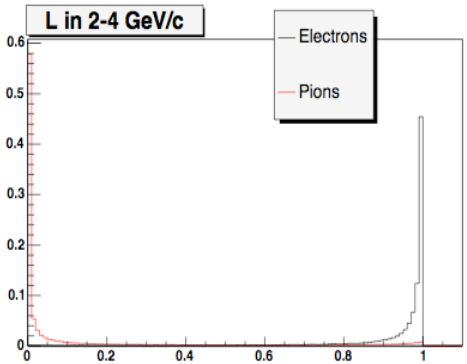
B^0 mixing

Current asymmetry results





Likelyhood function demo 2-4 GeV/c



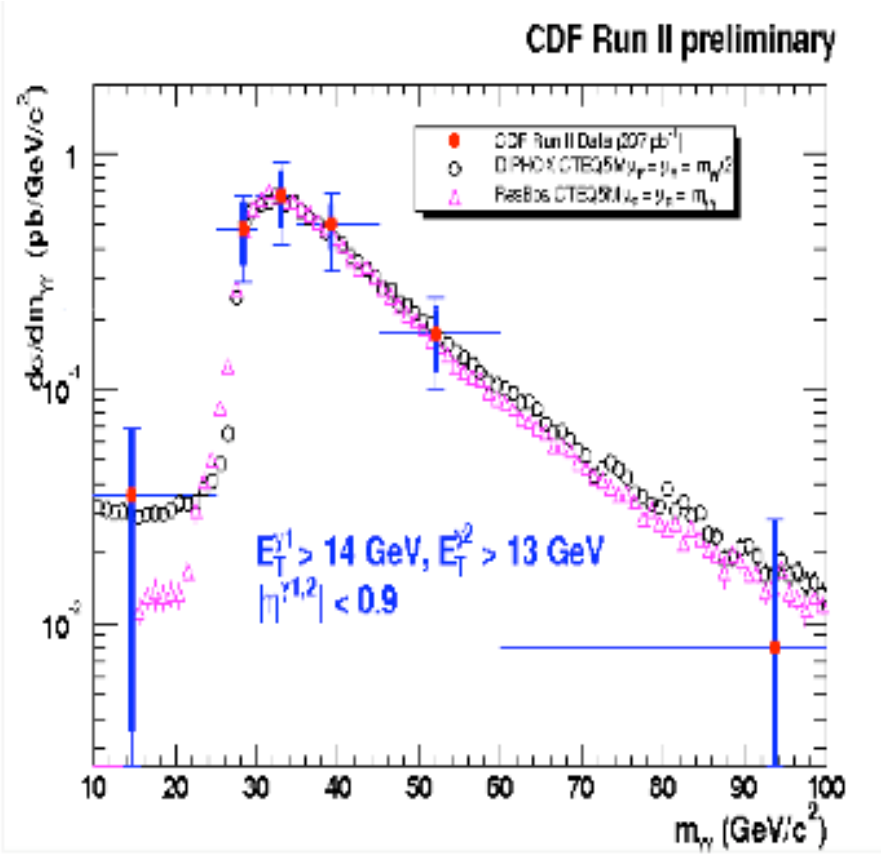
Soft e ID

Diphoton Production

Diphoton production is an interesting QCD process

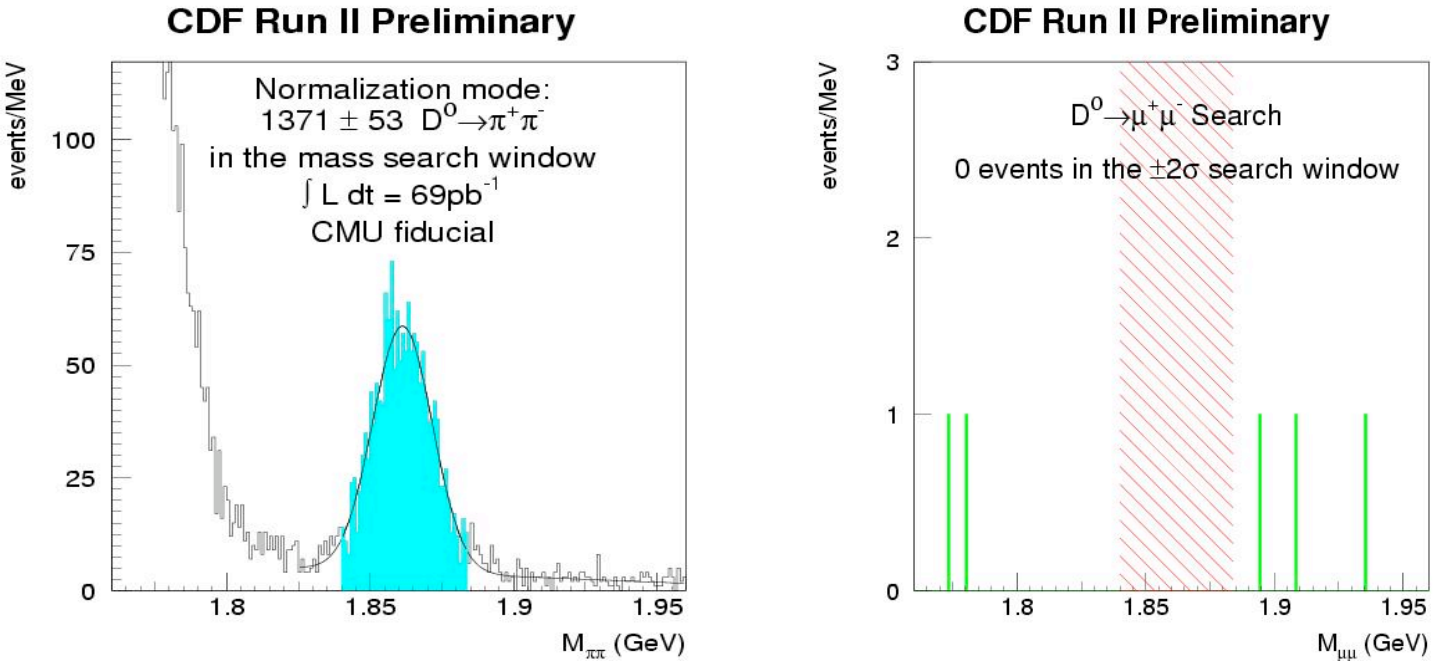
Needs to be understood well for Higgs searches here and there

DIPHOX has 2→3 frag, not in RESBOS



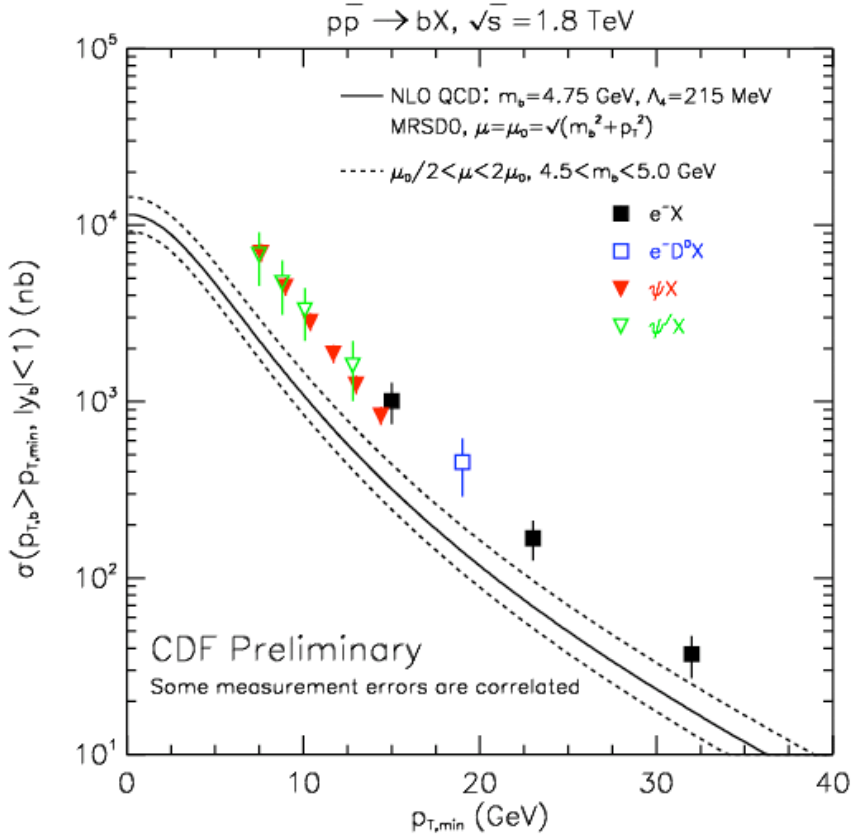
γγ mass

Some Local Physics
D^0->μμ (Ashmanskas et al.)



Use silicon SVT two track trigger to find D^0 to ππ, pions don't look like muons, best limit published $<2.4\ 10^{-6}$ PRD **68** 091191 (2003)

More Local Physics
b Cross Section (LeCompte et al.)



High b rates inspired quite an industry among theorists, notably including a sparticle interpretation:

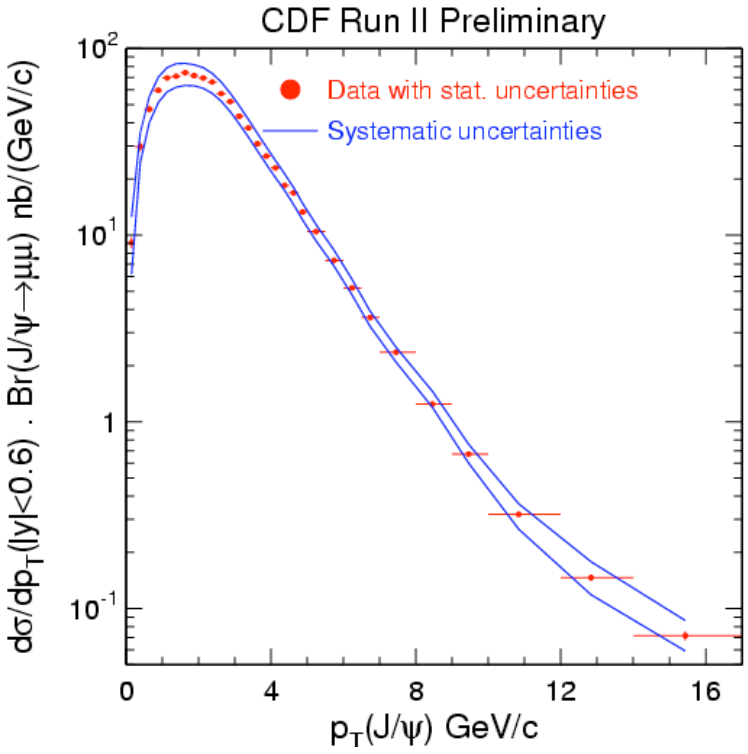
E.L. Berger, B.W. Harris (Argonne), D.E. Kaplan (Argonne & Chicago U., EFI), Z. Sullivan, T.M.P. Tait (Argonne), C.E.M. Wagner (Argonne & Chicago U., EFI),. ANL-HEP-PR-00-116, Dec 2000. 4pp.
Published in Phys.Rev.Lett.86:4231-4234,2001

Other work looked at fragmentation, NNLO, PDFs and notably good old K_T

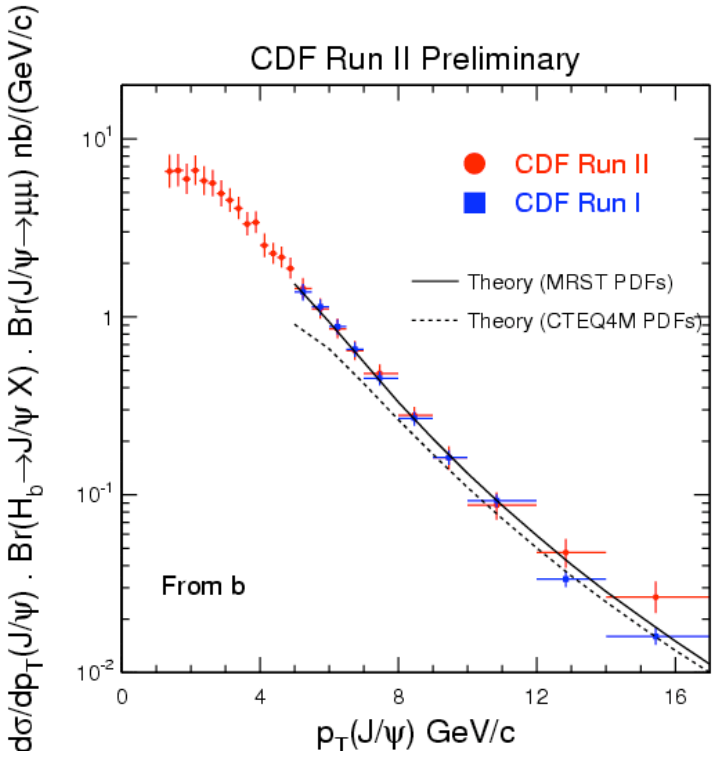
Measurements have been a local industry, 1997 shown, always top 5-10% of p_T

When in Doubt, Measure

- Modify dimuon trigger to allow ψ to p_T=0
- Measure ψ to p_T=0
- Use silicon to unfold b fraction
- Measure p_T integrated cross section for central $b \rightarrow \psi X$

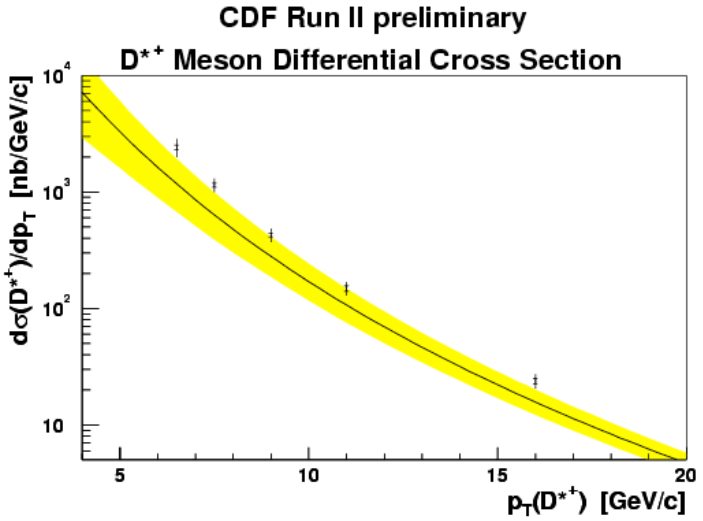


Evolved QCD B Production Seems Sufficient Now



Revised PDFs help too

And charm looks pretty much the same



σB from Hb |y|<0.6
CDF-II 24.5 ±0.5 ± 4.7 nb
σB |y|<1 29.4 ±0.6 ± 6.2 μb
cf NLO QCD MRAT2000 20+8-5 μb

Who Are We?

• Bill Ashmanskas	SVT,Acc.	Dimuon decay	to CLEO
• Bob Blair	Iso	QCD/γ search	ATLAS
• Karen Byrum	Cal, SM, SM L2	B production	Veritas
• Steve Kuhlmann	2b cal, Iso, SM	QCD/γ/Mjj-H	LC
• Tom LeCompte	(μ)	B production	ATLAS
• Larry Nodulman	CEM,Cal,SM,2b	Top/EWK/e/trig	ATLAS
• Jimmy Proudfoot	Ops,Trigger,SM	EWK	ATLAS
• Masa Tanaka	Ops, L2 Trig	B ID	
• Bob Wagner	e Offline,CEM	EWK->B	NUMI,VQuarknet
• Barry Wicklund	(B trig)	B trig strategy	LC, Atlas

Former physics group convener

Outlook

- All ANL/CDF members involved in other projects, many in ATLAS
- Lots of effort needed to get and keep things going: our stuff is doing well
- We respond to urgent needs e.g. Proudfoot, Tanaka deputy heads of ops & needs will grow
- CPR upgrade installs next (two?) fall shutdowns!
- Many TeV improvements pending: physics opportunity is (frustratingly) fabulous and just getting started
- Lots of good results will come!